A Globally Convergent Algorithm for Optimization Problems with Complementarity Constraints

Sven Leyffer and **Todd Munson***

Optimization problems with complementarity constraints arise in a wide variety of applications from robot motion planning to exploiting market power in electricity and emissions markets. These optimization problems are nonconvex and do not satisfy any standard constraint qualification at the solution. Many researchers, however, apply nonlinear programming methods to compute local solutions. These methods can be very successful and solve reasonably sized problems. This approach, however, does not preclude convergence to spurious stationary points having first-order descent directions.

We describe a new method for optimization problems with complementarity constraints that is globally convergent to local solutions. The method solves a linear program with complementarity constraints to obtain an estimate of the active set. It then fixes the activities and solves an equality-constrained quadratic program to obtain fast convergence. A filter is used to promote global convergence and we establish convergence to local solutions.

The practical performance of the algorithms depends on the quality of the problem formulation. Preprocessing technique simplify and strengthen the formulation prior to calculating a solution. A combination of rules exploiting the constraint set and the primal-dual characterization is applied to fix variables, improve their bounds, and eliminate redundant expressions. We describe our preprocessor for complementarity constraints and provide some results.

Finally, we describe our experience solving a problem examining the use of market power in the NO_x emissions market to drive up costs in the Pennsylvania-Jersey-Maryland electricity market. Analysis of the results shows that the producers having market power can gain substantial profit by withholding allowances and driving up NO_x allowances costs for the other producers. While the allowance price is higher than the corresponding price in the competitive case due to allowance withholding, the electricity prices are essentially the same.

*Mathematics and Computer Science Division, Argonne National Laboratory, Argonne, IL 60439. Research supported by the Department of Energy under Contract DE-AC02-06CH11357.